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PRINCIPAL INVESTIGATOR: Elizabeth C. Losos, Ph.D.

CONTRACTING ORGANIZATION: Smithsonian Tropical Research Institute
Washington, DC 20560

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13. ABSTRACT (Maximum 200 Words) The ICBG Associate Program for Biodiversity Inventory and Monitoring, Conservation and Training (AP1) is composed of three organizations: Smithsonian Institution's Monitoring and Assessing Biodiversity Program (SI/MAB), Center for Tropical Forest Science (CTFS), and the Bioresources Development and Conservation Programme. This report focuses on the use of phase-out funds provided by ICBG to enable AP1 - now ongoing for nine years - to maintain its projects in the short term while seeking new sources of funding to sustain the program over the long term. In addition, funds were to be used for the purpose of completing the enumeration of lianas in the 50-ha Korup Forest Dynamics Plot (Korup National Park, Cameroon) and for preparing research publications for peer reviewed journals. During this phase-out period, CTFS has also been active in continuing to build local capacity by providing training opportunities in a variety of areas. Our long-term goals are to continue monitoring and inventorying forest dynamics at the large (50 ha) and small (1-ha) scales. The large-scale plot data effectively address where diversity is found in relation to environmental factors, how it is maintained, and how it can be sustainably managed. The smaller plots provide data for understanding the distribution of diversity and forest composition changes over landscapes. Together these data provide key insights into the maintenance and dynamics of African tropical forests located in the critically endangered Congo Basin as well as inventory and harvesting data of biologically active compounds.				
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**INTERNATIONAL COOPERATIVE BIODIVERSITY GROUP (ICBG) ON DRUG
DEVELOPMENT AND CONSERVATION OF BIODIVERSITY
IN WEST AND CENTRAL AFRICA.**

Walter Reed Final Report for Award Number DAMD17-99-2-9024

Research Period: October 1, 2003 – December 31, 2004

I. Introduction

The original objectives of AP1 (SI/MAB and CTFS) were to enhance the link between the information collected in the biodiversity plots and the large-scale Korup Forest Dynamics Plot (KFDP) with that of the other APs in the ICBG. CTFS will continue its research in Korup, collecting long-term forest dynamics data in the 50-ha Forest Dynamics Plot and making this information available to the other APs as well as others interested in drug discovery. KFDP will continue working towards its long-term goal of generating (a) an understanding of the process necessary for generating and maintaining the high biodiversity of the region, with the objective of providing information for the development of management strategies that will conserve this biodiversity; (b) identify the ecological and taxonomic distribution of plant species of economic and medicinal importance in different forested habitats, in order to develop strategies for their sustainable harvest or cultivation; and (c) continue training in-country partners, in order to expand the capacity of Cameroon to manage their natural resources. As other funds are secured, future studies will build on the ecological and taxonomic studies already funded by ICBG in Phases I and II. In the interim, Associate Program 1's specific objectives were the following:

1) Completion of Liana Census within Korup Forest Dynamics Plot. During this phase-out period, our core staff were to continue work on the liana census. Completion of the Korup liana census is extremely valuable to the long-term viability of the project as this information is important to understanding the structure of Central African forests, and especially to understanding medicinal chemicals.

2) Core maintenance of the 50-ha plot. In its nine year history of our ICBG program, funds have enabled AP1 to hire and train local researchers to establish, map, enumerate, and maintain the 50-ha Korup Forest Dynamics Plot. Over the course of the grant, ICBG funds have supported the salaries of these vital in-country members of the project. The phase-out funds were to be used to retain the core KFDP and their activities while we sought alternative funds for their continued employment.

3) Production of Publications from the Korup Forest Dynamics Program. The investment in establishing a Forest Dynamics Plot has been large, both in terms of time and labor. At the end of this inventory and enumeration stage, it is critical that we disseminate the information gathered. There are two important audiences that we are targeting: The scientific community (reached largely through peer-reviewed publications and lectures) and the conservation and management community in Cameroon (reached through reports and lay public publications). These publications are not only important to disseminate the findings of this work, but also to provide a foundation from which to continue to obtain funding and governmental authorization for future censuses of the plot. Thus, for this phase-out period, our senior scientists in the US and Cameroon were to focus on the final clean up of difficult identifications, the writing of peer-review articles, and the preparation of lectures for scientific and management audiences.

4) Development of proposals for alternate funding sources. The Smithsonian Institution has committed itself to supporting long-term research in Korup, Cameroon as well as other vital areas in the Congo Basin. During the phase-out period, Smithsonian and KFDP developed proposals for a variety of potential funders of the research, including the US National Science Foundation, US Agency of International Development's Central African Regional Program for the Environment (CARPE), and a variety of foundations in order to obtain funds for the long-term goals of this project.

5) Conduct and support travel to training sessions. As part of our investment in the long-term sustainability of the program, AP1 had already begun planning various training sessions which are necessary to keep KFDP core staff and in-country researchers up-to-date with the most current research methods and analyses. As such, during the phase-out grant, AP1 had plans to leverage other funds to

support the following training sessions for KDFP researchers: a) Soils Workshop in Panama (attendance by Dr. George Chuyong), b) Botanical training workshop in Cameroon (coordinated by Dr. Duncan Thomas, David Kenfack, Dr. Terry Sunderland, and funded by CARPE), and c) CTFS Analytical Workshop IV (attendance by Dr. Duncan Thomas, Dr. George Chuyong, and David Kenfack – funded by NSF). In particular, ICBG phase-out funds were to contribute to these activities by supporting David Kenfack and Dr. George Chuyong to prepare for these various training sessions.

II. Body: Research and Other Accomplishments

Korup Forest Dynamics Plot Progress Report

Phases I and II of the ICBG saw the 50-ha Korup Forest Dynamics Plot move from plan to reality. An enormous research program was developed by CTFS and BDCPC, under on-going agreements with the Ministry of Environment and Forests, Korup National Park, and Limbe Botanical Garden. A research camp was constructed in the National Park near the plot, and an office building was rented in the nearest town, Mundemba. In part due to phase-out funds from ICBG, KDFP core staff – including Dr. Duncan Thomas, Dr. George Chuyong, David Kenfack, Sainge Moses, Peter Mambo, and Augustine B. Njamnshi (BDCPC) – were able to continue on-going ecological studies rather than seek alternative employment. Several set-backs did occur over the last nine months which delayed progress – late fund transfers delayed several projects, renegotiations with the Korup National Park Conservator limited entry of researchers into the KDFP area, and reduced funding lessened research activities. The problem with the park agreement was resolved by the end of January 2004 when BDCPC partners (Dr. Tata F. Thomas and Augustine Njamshi) met the Director of Wildlife. These issues resulted in some delay in the maintenance of the 50-ha plot and the liana census. Despite these adversities, the KDFP core staff has managed to accomplish vital research which will enable the project to maintain itself until additional funds are found to begin the recensus.

I. Phase-out Field Season Activities. Approximately 2,300 trees were sampled on a transect surrounding KDFP, phenology studies were carried out by Dr. George Chuyong, and a reconnaissance survey of Rumpi Hills was conducted by Sainge Moses. Phenology studies were carried out three times throughout the year and all data entered. Forty-nine fertile plant specimens were also collected by Sainge Moses (1293 - 1341), as requested by the Conservator of the Limbe Botanic Garden, and sent to the LBG herbarium. In addition, a new gas (Butane) plant drier for drying of KDFP specimens at Mundemba was constructed.

Dr. Duncan W. Thomas and Sainge N. Moses also visited the Mount Oku forest and lake for a comparative ethnobotany and phenological fieldwork. During this trip, individuals of the families Acanthaceae, Lamiaceae, and Meliaceae were collected (representing the genus *Mimulopsis*, *Oreacanthus*, *Plectranthus*, *Brillantaisia* and *Carapa*). This trip will allow KDFP researchers to develop methods and information for community-based recording of plant names at different sites.

The Korup National Park is also known to be a center of genetic diversity for *Phytophthora megakarya*, the pest causing black pod disease of cocoa in Central and West Africa. Researchers believe that the black pod pathogen has developed in association with the *Cola* species (family: Sterculiaceae). Researchers are utilizing the Korup plot to investigate the possibility that cocoa (*Theobroma cacao*) may possibly be infected with the black pod pathogen which could have jumped from *Cola* to cocoa. Specifically, Sainge Moses of KDFP is working with the Cameroonian research agency IRAD, Yaounde, and researchers from the US Department of Agriculture to find fungi that may be able to serve as biological control agents against the black pod disease. It is likely that *Phytophthora megakarya* evolved along with its natural antagonists in the Korup region. Sainge Moses has conducted an initial exploratory investigation in KDFP to determine whether potential biological control agents can be found in the park. He spent approximately one week in the park observing *Cola* trees and the decaying fruit of *Cola altissima* and *Irvingia gabonensis* (bush mango) for the presence of the *Phytophthora* and potential biological control agents. If this exploratory research confirms the existence of the black pod pathogen and possible biological control agents, KDFP researchers will participate in a proposal to undertake extensive research in the Korup Park for biological control agents against the black pod pathogen.

Duncan Thomas has recently compiled an extensive database with ethnobotanical information for the KDFP area. In order to expand this database, he is adding fields such as life-form, habitat, and distribution to analyze patterns of plant use by local communities. One obvious trend is that secondary forest/fallow is very important as a source of NTFPs. These findings will be the focus of a peer-reviewed

publication, which will also discuss the significance of this finding for land-use planning and rural development.

ii. Lianas. The KFDP liana dataset now covers a total of about 18 hectares, making it one of the largest datasets on tropical forest lianas in the world. The ICBG-funded census is on-going and each liana included in the census dataset is now assigned a code name or species name, coordinates which indicate its location within the plot, diameter measurements, and host tree tag numbers. The first set of data (of the double-entry data process) is being entered rapidly, so that a dataset will be available for preliminary analysis soon after the completion of the field data collection. In November 2003, some slight amendments were made to the lianas inventory methods for KFDP, such as documenting the relationship between tagged liana individuals and host trees.

In terms of taxonomy, we have found that the lianas are more difficult to identify than trees, and there appear to be at least as many rare and new species among them. Specimens from the family Annonaceae are particularly difficult to match, and several new liana species are expected from this family. In terms of ecology, the lianas make a very interesting comparison with the trees, and will be used to study patterns of diversity.

In order to manage collected vouchers of trees and lianas in the plot, sets of representative vouchers for each species are now deposited at the Limbe Botanical Garden in Cameroon and at the Missouri Botanical Garden, besides the collection which is housed at the KFDP headquarters in Mundemba. Establishing the voucher repositories is making the identification of species from the plot much easier. Identification of trees, lianas, and other plants from the KFDP area will continue at the Limbe Botanical Garden and the Missouri Botanical Garden.

"Distributions of rattan species in an African forest", lead authors: D. Thomas, T. Sunderland, G. Chuyong, D. Kenfack, S. Moses, will be the first publication from the KFDP liana dataset. In order to complete this publication in a timely fashion, we have focused on the extraction of rattan data from the main dataset, checked it for errors, and are currently placing the newly acquired rattan data from the on-going census as a priority for checking, data entry, and processing. Rattans provide a number of non-timber forest products in Cameroon, and are of economic importance for rural communities, and for urbanized manufacturers of rattan products. Seven rattan species have been found in the KFDP so far, of which two were recently described as new species and one still remains unknown. These results indicate that even for an economically important group like rattans, their biology remains very poorly known. We expect to complete this publication once the rattan dataset is finalized, hopefully by the end of 2004.

iii. Preparation of publications. As demonstrated by presentations at our recent symposium at the Limbe Botanical Garden, our research in Korup, Takamanda, and (soon) Cross River are ripe for analyses and dissemination in peer-reviewed journals. Several additional papers are ready to be prepared for publication. These papers include:

- Kenfack D., Ewango E.N., and D.W. Thomas. *Manilkara lososiana* Kenfack & Ewango, a new species of Sapotaceae from Cameroon (accepted by *Kew Bulletin*).
- Kenfack D., Sainge M.S. and D.W. Thomas. A new species *Cassipourea korupensis* Kenfack & Sainge from Western Cameroon (submitted to *Novon*).
- Thomas, D.W., Kenfack, D. and G. Chuyong. 2004. Measuring the alpha diversity of trees: Is this a useful tool for biodiversity assessment?" *Inside CTFS*.
- Kenfack, D. and D.W. Thomas. Korup Species Inventory. (To be published as a chapter of "Systematic Studies in Africa and Madagascar", part of the series *Monographs in Systematic Botany in Annals of the Missouri Botanical Garden* by September 2004.
- Kenfack, D. and D.W. Thomas. Species Description of *Crotonogynopsis* nov. sp. (to be submitted to *Novon* by December 2004.)
- Kenfack, D.W., Thomas, D.W., Chuyong, G., Losos, E.C., and R. Condit. Floristics of Korup Forest Dynamics Plot. (To be submitted to *Vegatio* by February 2005.)
- Chuyong, G., Kenfack, D.W., Thomas, D.W., Losos, E.C., and R. Condit. Population Structure and Habitat Associations within Korup Forest Dynamics Plot. (To be submitted to *Journal of Ecology* by September 2004.)
- Thomas, D.W., Kenfack, D.W., Chuyong, G., Condit, R. and E.C. Losos, Assessing Rapid Biodiversity Sampling Techniques. (To be submitted to *Conservation Biology* by September 2004.)
- Thomas, D.W., Sunderland, T., Chuyong, G., Kenfack, D., and M. Sainge. Distributions of rattan species in an African forest, (To be submitted by December 2004.)
- Thomas, D.W., Kenfack, D.W., Chuyong, G., Losos, E.C., and Condit, R.. Ethnobotany of the Korup National Park.

- Comiskey, J.A. and T. Sunderland. Floristics comparison of Takamanda Forest Reserve plots and Korup Forest Dynamics plots. (To be submitted to *Journal of Tropical Ecology*.)

iv. Preparation of proposals for alternative funding. In 2004, the Central African Regional Program for the Environment (CARPE) awarded CTFS and the Smithsonian Institution — Monitoring and Assessment of Biodiversity (MAB) funds to conduct botanical training workshops in Cameroon and establish 1-ha exploratory plots in Cameroon and Gabon.

The Smithsonian is also currently preparing letters of inquiry for various funding agencies including: New England Biolabs Foundation, Meyer Memorial Trust, The Coca-Cola Africa Foundation, Sempra Energy, The Lawrence Foundation, UN Foundation, Aventis Foundation Karl Winnacker Fund, and have started discussions with the International Program of NSF.

Management and Training

One of the primary goals of AP1 is to train researchers from West Africa in biodiversity assessment and monitoring, and the collection, management, and analysis of taxonomic and ecological data. Training efforts to date have enhanced scientific infrastructure, built links between US, Cameroonian, and Nigerian researchers, and laid groundwork for continuation of the project and incorporation of additional partners. At present, training activities have focused within the large and small plots, through organized courses, and through scientific exchanges.

i. Soils and Hydrology Workshop in Panama. Funded by NSF, Dr. Kyle Harms (University of Louisiana), Dr. James Dalling (University of Illinois), Dr. Robert Stallard (US Geological Survey), and Dr. Joseph Yavitt (Cornell University) organized and coordinated a workshop at the Smithsonian Tropical Research Institute in Panama which addressed the interrelations among soil properties, hydrology, and the forests found within several of the large-scale Forest Dynamics Plots within the CTFS network. The goal of this workshop was to instruct CTFS partners to use a standardized protocol to measure key soil and hydrologic properties in the Forest Dynamics Plots. KFDP researcher, Dr. George Chuyong successfully participated in this workshop and will begin implementing this protocol in future soils research at KFDP.

ii. Botanical training workshop in Limbe Botanic Garden, Cameroon. Funded by CARPE and coordinated by David Kenfack (CTFS), Dr. Terry Sunderland (SI-MAB), and Dr. Duncan Thomas (CTFS), the Smithsonian Institute and Missouri Botanical Garden hosted a workshop (July 18 -25, 2004) entitled "A Landscape Approach to Measuring and Conserving Plant Diversity in the Congo Basin", with the aim of teaching standard botanical inventory techniques to technicians and botanists working within Central Africa. Twenty-five botanists and technicians from six Central African countries participated in the workshop.

iii. CTFS Analytical Workshop Series. With funding from the US National Science Foundation, CTFS hosts an annual meeting of three to four weeks of duration with the objective of training scientists from the plots in the CTFS network in the statistical tests needed to analyze the datasets, and to work on publications from both individual plots and from the network. Workshops have focused on statistical analyses of diversity, species/area, spatial patterns, the production of graphics, associations between species and habitat, and calculating growth, recruitment, and mortality of trees. For the last three years, the workshops have been successfully attended by three KFDP scientists (Thomas, Kenfack, Chuyong). As a result, KFDP produced a Stand Table Book which was published by CTFS in 2003. In addition, substantial progress has been made on a series of publications from the Korup dataset on the structure, diversity, species habitat associations and floristics of the plot. During the fourth workshop, which was held in Taiwan in August 2004, Thomas, Kenfack, and Chuyong continued working with the KFDP dataset to analyze habitat associations, neighborhood effects on tree distributions, and assess population dynamics of related taxa. In conjunction with the workshop, Dr. Thomas presented a talk entitled "Biodiversity and Forest Dynamics in Central Africa" at the CTFS Network-Wide Symposium which was held in Taipei, Taiwan on August 16 – 17, 2004.

III. Key Research Accomplishments

- Completion of Liana Census within Korup Forest Dynamics Plot
- Core maintenance of the 50-ha plot
- Production of Publications from the Korup Forest Dynamics Program and the Takamanda Forest Reserve plots
- Development of proposals for alternate funding sources
- CTFS and SI-MAB were awarded funds from CARPE
- Conduct and support travel to training sessions

IV. Reportable Outcomes

Book (Attached as Appendix I)

- Elizabeth C. Losos and Egbert G. Leigh, Jr. (editors) 2004. Tropical Forest Diversity and Dynamism: Findings from Large-Scale Plot Network. The University of Chicago Press, Chicago Illinois, USA.

Chapters in Book

- G.B. Chuyong, R. Condit, D. Kenfack, E. Losos, M. Sainge, N.C. Songwe, D.W. Thomas. 2004. Korup Forest Dynamics Plot, Cameroon. Chapter 29 *In: Tropical Forest Diversity and Dynamism: Findings from Large-Scale Plot Network*. Edited by Elizabeth C. Losos and Egbert G. Leigh, Jr. The University of Chicago Press, Chicago Illinois, USA.

Peer Reviewed Article

- Chuyong, G. B., Newbery, D. M., and N. C. Songwe. 2004 Rainfall input through fall and stem flow of nutrients in a central African rain forest dominated by ectomycorrhizal trees. *Biogeochemistry* 67: 73-91

Newsletter Article

- Thomas, D.W., Kenfack, D. and G. Chuyong. 2004. Measuring the alpha diversity of trees: Is this a useful tool for biodiversity assessment?" *Inside CTFS*.

V. Conclusions

The Monitoring and Assessing Biodiversity Program (MAB) continues to provide in-country participants with the capacity to conduct biodiversity assessments in areas considered to be of conservation importance through a series of training courses. Research at the Takamanda Forest Reserve has also yielded a series of publications detailing biodiversity in Cameroon and highlighting areas of conservation. MAB will continue to coordinate with CTFS in the establishment of exploratory plots in Cameroon and Gabon thanks to funding by CARPE.

While CTFS continues to seeking long-term funding to support the Korup Forest Dynamics Plot and its recensus, Drs. Duncan Thomas, George Chuyong, and Mr. David Kenfack will finalize and submit various manuscripts that are currently in preparation. Disseminating the findings of the Korup 50-ha plot will not only benefit the greater scientific community but will also allow CTFS to leverage funding from alternate sources. Scientists from the Korup Forest Dynamics Plot, will also be active participants in the fifth Analytical Workshop Series, coordinated by the Center for Tropical Science, which will be held in Panama in June 2005. The training at these workshops has already provided participants with the basic skills necessary to continue data analysis and management currently employed at the site. In order to produce meaningful results and understand the dynamics of this forest, the Korup Forests Dynamics Plot will need to complete a recensus of this 50-ha plot. This is our main priority and goal to maintain this long-term large-scale research plot.

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